Original Article

Performance of Kenyan athletes in mountain versus flat marathon running - An example in Switzerland

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ABSTRACT

Harm, C., Knechtle, B., Rüst, A.C., Rosemann, T., Lepers, R. & Onywera, V. (2013). Performance of Kenyan athletes in mountain versus flat marathon running - An example in Switzerland. *J. Hum. Sport Exerc*., *8*(4), pp.881-893. The purpose of this study was to compare running performance of Kenyans in a flat city marathon and a mountain marathon in Switzerland. Running times of top three overall Kenyan runners were compared with running times of top three overall runners of other nations in a mountain and a flat marathon held in Switzerland between 2003 and 2011. In the mountain marathon top three male Kenyans achieved with 199±23min the 11th fastest running time behind athletes from Italy (177±1min), Switzerland (179±0min), France (186±5min), Great Britain (189±3min), Mexico (189±3min), Germany (192±5min), Czech Republic (195±13min), Morocco (195±7min), USA (196±6min) and Hungary (198±8min). Female Kenyan athletes did not even participate in the mountain marathon. In the city marathon top three male Kenyan athletes achieved the second fastest running time (130±1min) behind Swiss athletes (129±1min), Kenyan female runners had the fifth fastest running time (158±4min) behind athletes from Russia (153±2min), Ethiopia (154±2min), Switzerland (155±2min) and Poland (155±4min). To summarize, in Switzerland, Kenyans achieved not the fastest running times in a mountain marathon while they attained the second fastest running times in flat marathon. **Key words**: EAST AFRICA, ALTITUDE, MOUNTAIN, LONG-DISTANCE RUN.

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INTRODUCTION

Marathon running is a long-distance running event with an official distance of 42.195 km. It is generally held as a road race, which should be performed on, made up roads and running on soft surfaces is not allowed (www.iaaf.org). In contrast, a mountain marathon is a marathon, which must go uphill or up- and downhill. There must be a total amount of ascend for more than 1,600 m and it is not allowed that the race contains any dangerous sections such as crossing glaciers, requiring rock climbing or mountain climbing assistance (www.wmra.ch).

East African Runners dominated middle-and long-distance running events in the World Cross-Country Championships of the IAAF since the 1990s (Wilber & Pitsiladis, 2012). This dominance has especially been well reflected in the major road marathons over the past ten years. The best 19 running times in the year 2011 were all held by Kenyans (www.iaaf.org). Additionally, Kenyan runners always won the `World Marathon Majors Series` since their foundation in 2006 (http://worldmarathonmajors.com). In the `Berlin Marathon` in 2011 the Kenyan Patrick Makau Musyoki set a new world record in a time of 2:03:38 h:min:sec for men. Among women, the dominance of Kenyan runners in marathon is less pronounced. Beside the East African runners Tegla Loroupe, Mary Keitany and Catherine Ndereba, other female athletes from countries such as England (Paula Radcliffe), Russia (Lilya Shabukhova), Japan (Mizuki Noguchi) and Germany (Irina Mikitenko) were very successful in the past ten years (www.iaaf.org). The world record is still held by Paula Radcliffe in a time of 2:15:25 h:min:sec set in 2003.

The main reason for these outstanding performances of Kenyans in middle and long distance runs are thought to be the better running economy (Joyner et al., 2010; Lucia et al., 2006; Prommer et al., 2010; Weston et al., 2000). It is based on specific anthropometric characteristics such as the low body mass index (Larson, 2003; Lucia et al., 2006; Prommer et al., 2010) and the long and slender legs (Larson, 2003; Lucia et al., 2006; Prommer et al., 2010) allowing the Kenyans to run with minimal energy. This low energy consumption reduces the oxygen cost of running (Joyner et al., 2011; Larson, 2003; Prommer et al., 2010; Weston et al., 2000).

Besides the running economy, the intensive training methods with consistent running at race pace (Billat et al., 2003; Wilber & Pitsiladis, 2012), the chronic exposure to altitude (Bailey & Davies, 1997; Brutsaert, 2008), the early introduction of children to running due to the fact that a great part of Kenyan children have to run to school for several kilometres (Onywera et al., 2006), the diet during training (Beis et al., 2011; Fudge et al., 2006; Onywera et al., 2004), the environmental background and especially the motivation (Onywera et al., 2006; Wilber & Pitsiladis, 2012) also seem to have an effect on the success of the Kenyans in road marathons. In Kenya there is a high rate of unemployment and poverty among the general population (Onywera et al., 2006). Being a competitive athlete is combined with financial improvement offering the Kenyans a way out of poverty (Onywera et al., 2006). As discussed by Onywera et al. (2006) 33% of the international Kenyan athletes claimed to run for economic reasons. East African runners attend marathons all over the word especially the financially profitable major marathons in Europe, North America and Asia are favoured (www.kenyapage.net).

The influence of living and training at altitude on Kenyan success in road marathons has been well investigated (Prommer et al., 2010). The majority of Kenyan athletes are born and raised in the province Rift Valley (Onywera et al., 2006) with an altitude between 1,700m and 4,100m above sea level (Moore et al., 2007). The chronic exposure to altitude and hypoxia is connected with cardiopulmonary (Bärtsch & Gibbs, 2007; Brutsaert, 2008; Favier et al., 1995), haematological (Beall et al., 2002; Moore et al., 2007)

and muscular adjustments (Hoppeler & Vogt, 2001) leading to an improved endurance capacity and running economy at altitude (Bailey & Davies 1997; Brutsaert, 2008). These specificities should help Kenyans to achieve also great running performance in mountain marathons. However, the influence of altitude on the performance at sea level is still controversially discussed. At the moment there is only a benefit for the `live-high train-low model` described (Bonetti & Hokins, 2009; Chapman & Levine, 2007; Saunders, 2009). Kenyan dominance also tried to be explained through physiological and genetically differences between the races (Larson, 2003; Scott & Pitsiladis, 2007). When Caucasian und East African runners were compared, there have been no differences in maximum oxygen uptake (Prommer et al., 2010), leg muscle oxidative enzyme concentration (Larson, 2003; Saltin, 1995), muscle-fibre type distribution (Larson, 2003) or density of the capillarisation in the musculature (Larsen et al., 2003). Furthermore there seem to be no genetic susceptibility, which can explain the dominance of the East African runners (Scott & Pitsiladis, 2007).

Based upon these findings, the aim the present study was to compare the running performance between Kenyan athletes and athletes of other nations in a mountain marathon, the `Jungfrau Mountain Marathon versus a flat city marathon, the `Zürich City Marathon`, both held in Switzerland during the 2003-2011 period. Additionally, we also investigated the changes in participation and running performance of the top ten overall men and women in both marathons over time. The reasons to choose Switzerland were based on the central location in Europe, the ability to offer both routes (a mountain marathon and a road marathon) and the high prize money of 10.000 Swiss francs (individual premiums for accession and costs for travelling excluded) for a victory in both races (www.zurichmarathon.ch; www.jungfrauzeitung.ch). Because Kenyan runners had high running economy and are familiarized with altitude, we hypothesized that they would dominate both flat city and mountain marathons.

MATERIAL AND METHODS

This study was approved by the institutional review board of St. Gallen, Switzerland, with waiver of the requirement for informed consent given that the study involved the analysis of publicly available data. The data set for this study was obtained from the race website of `Zürich Marathon`(www.zurichmarathon.ch) and from `Datasport` (www.datasport.com) responsible for the ranking for `Jungfrau Marathon`.

Races

Road marathon `Zürich City Marathon`

The `Zürich City Marathon` is a loop-course close to the `Zürich Lake` with a length of 42.195 km. It takes place at an altitude of 408 m above sea level with an elevation change of 0 m/km. There are every 3.5 km fluid and food stations along the course (www.zurichmarathon.ch).

Mountain marathon `Jungfrau Marathon`

The `Jungfrau Mountain Marathon` starts in `Interlaken` at an altitude of 567 m above sea level and ends at the `Kleine Scheidegg` 2,104 m above sea level. The highest point reached is at 2,204 m above sea level. The overall difference in altitude to climb is 2,134 m with 1,829 m uphill and 305 m downhill, respectively (www.jungfrau-marathon.ch).

Data analysis

All female and male runners who ever successfully finished between 2003 and 2011 the flat marathon and the mountain marathon were analyzed regarding the association between nationality and performance. The change in running performance of the top ten athletes (i.e. ten fastest running times) for both men and

women was analyzed from 2003 to 2011. The sex difference was calculated using the equation sex difference [%] = (race time in women [min] – race time in men [min]) / race time in men [min] ×100. To facilitate reading, all sex differences were converted to absolute values. As a last step we analyzed the running time and age of the top athletes of every nation where only the top three athletes per nation could be included. Countries with less than three athletes in total could not be included into analysis.

Statistical analysis

In order to increase the reliability of the data analyses, each set of data was tested for normal distribution as well as for homogeneity of variances in advance of statistical analyses. Normal distribution was tested using a D'Agostino and Pearson omnibus normality test and homogeneity of variances was tested using a Levene's test in case of two groups and with a Bartlett's test in case of more than two groups. To find significant changes in the development of a variable across years, linear regression was used. To find significant differences between two groups, a student's t-test was used in case of normal distributed data (with additional Welch's correction in case of significantly different variances between the analysed groups) and a Mann-Whitney test was used in case of not normal distributed data. Differences between multiple groups were analysed using one-way-analysis of variance (ANOVA) with subsequent Tukey-Kramer post-hoc analysis. Statistical analyses were performed using IBM SPSS Statistics (Version 19, IBM SPSS, Chicago, IL, USA) and GraphPad Prism (Version 5, GraphPad Software, La Jolla, CA, USA). Significance was accepted at $P < 0.05$ (two-sided for t-tests). Data in the text are given as mean ± standard deviation (SD).

RESULTS

During the studied period, a total of 7,408 (17.9%) women and 33,870 (82.1%) men finished the flat city marathon, while 5,944 (14.1%) women and 36,342 (85.9%) men finished the mountain marathon.

Participation trends

The number of finishers decreased for the flat city marathon (Figure 1A) while it increased for the mountain marathon (Figure 1B). The main part (99%) of athletes in both marathons originated from Europe. Women represented on average 17.9% of the total field in the flat city marathon and 14.1% in the mountain marathon, respectively.

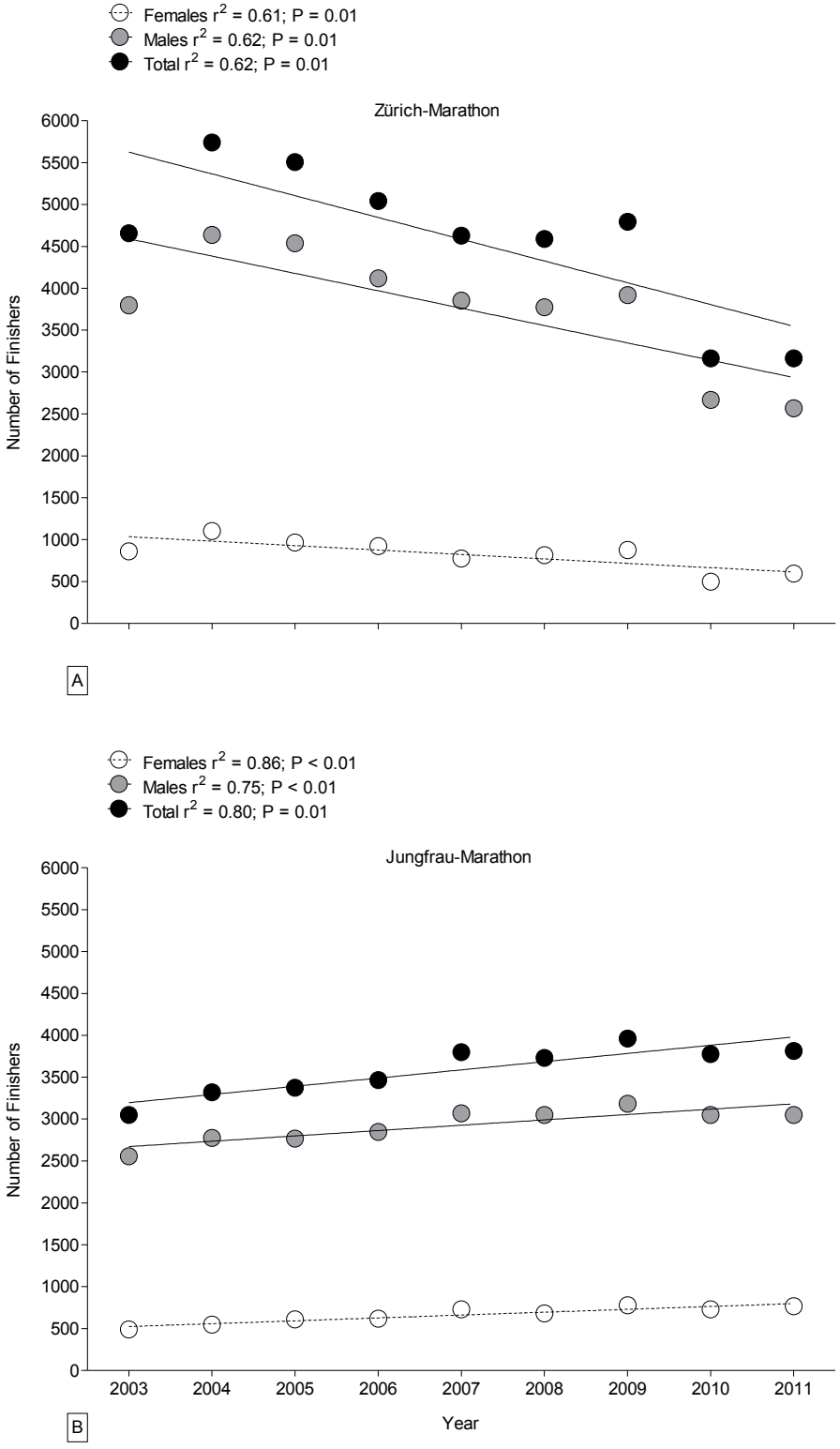

***Figure 1**. Annual number of male, female and total athletes competing in 'Zürich Marathon` (Panel A) and `Jungfrau Marathon` (Panel B)*

Running times of the top ten men and women overall

In the flat city marathon, the mean running time of top ten overall was 129.6±0.2min for men and 152.8±0.3min for women, respectively. The sex difference in running time for the overall top ten athletes was 17.9±0.4% (Figure 2). In the mountain marathon, the mean running time of top ten overall was 177.2±1.0min for men and 206.5±1.1min for women, respectively. The sex difference in running time for the overall top ten athletes was 16.5±1.2% (Figure 2). There have been no change in running time of the annual top ten athletes for both sexes in the flat city (Figure 3A) and mountain marathon (Figure 3) over the period from 2003-2011.

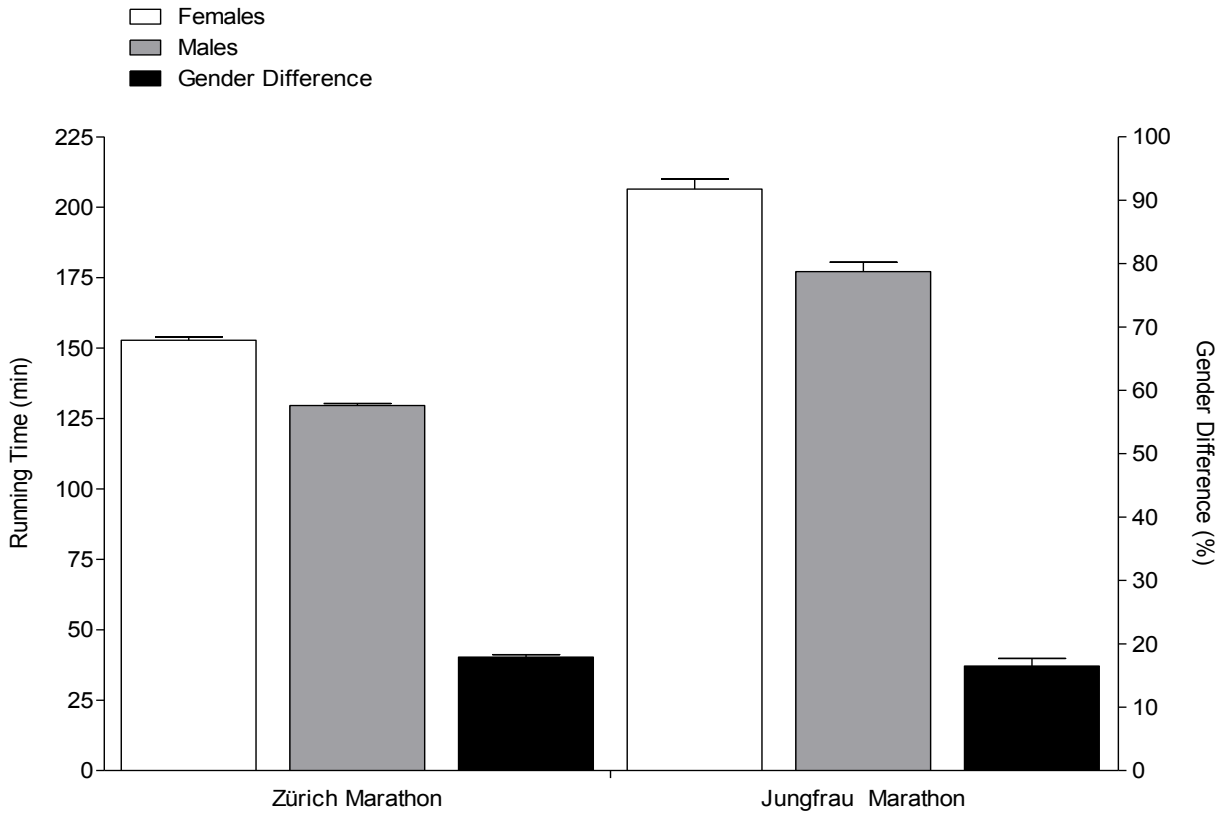

Figure 2. *Running time of the overall top ten male and female athletes competing in `Zürich Marathon` and `Jungfrau Marathon`.*

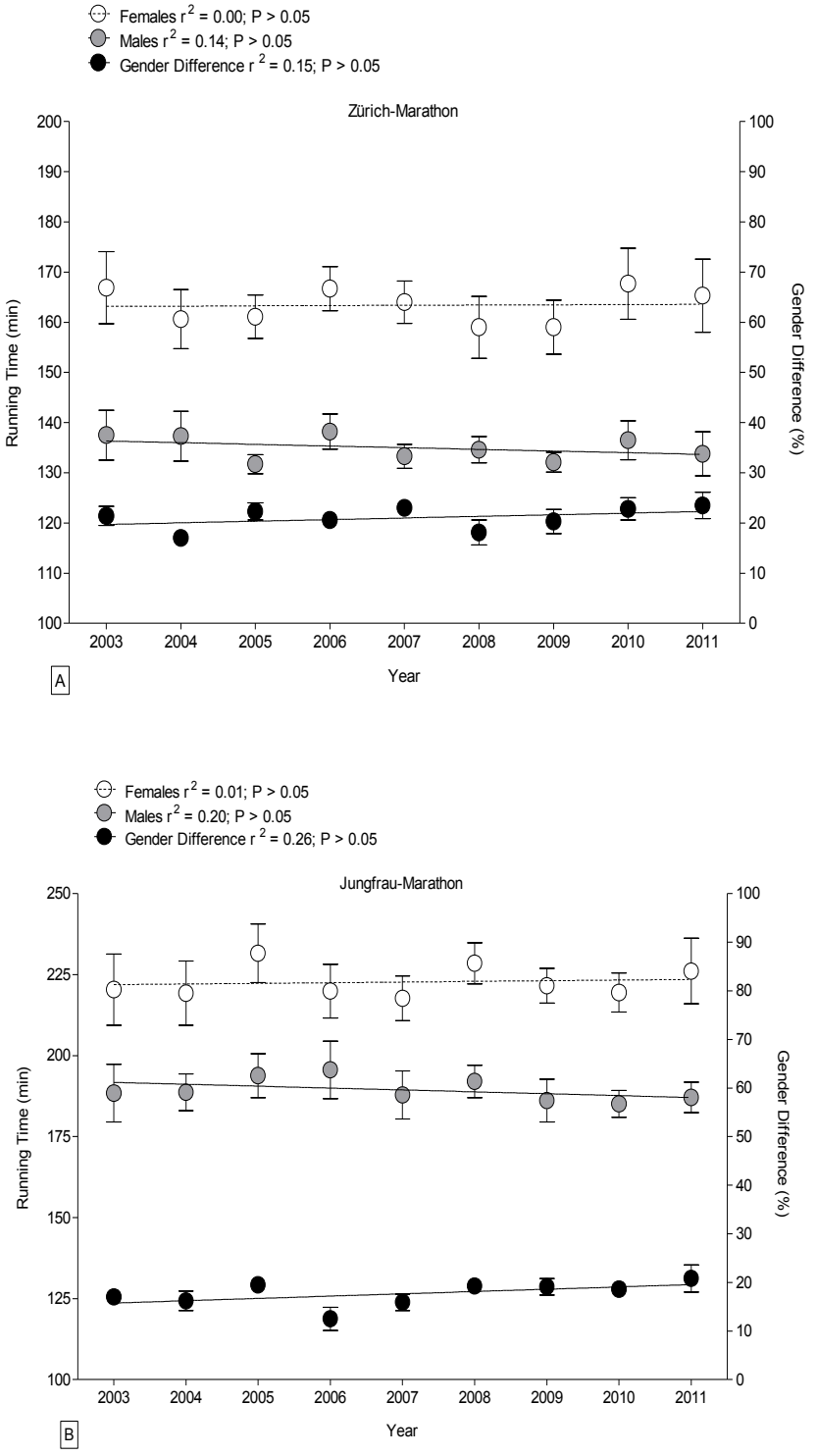

Figure 3. *Running time of the top ten male and female athletes per year competing in `Zürich Marathon` (Panel A) and `Jungfrau Marathon` (Panel B)*

Performance of Kenyans in the flat city marathon

The overall top three male Kenyans achieved with a mean running time of 130±1 min the second fastest running time behind the leading male Swiss athletes (129±1min) (Figure 5A). The overall top three female Kenyan athletes achieved with a mean running time of 158±4min the fifth fasted time behind athletes from Russia (153±2min), Ethiopia (154±2min), Switzerland (155±2min) and Poland (155±4min) (Figure 4A).

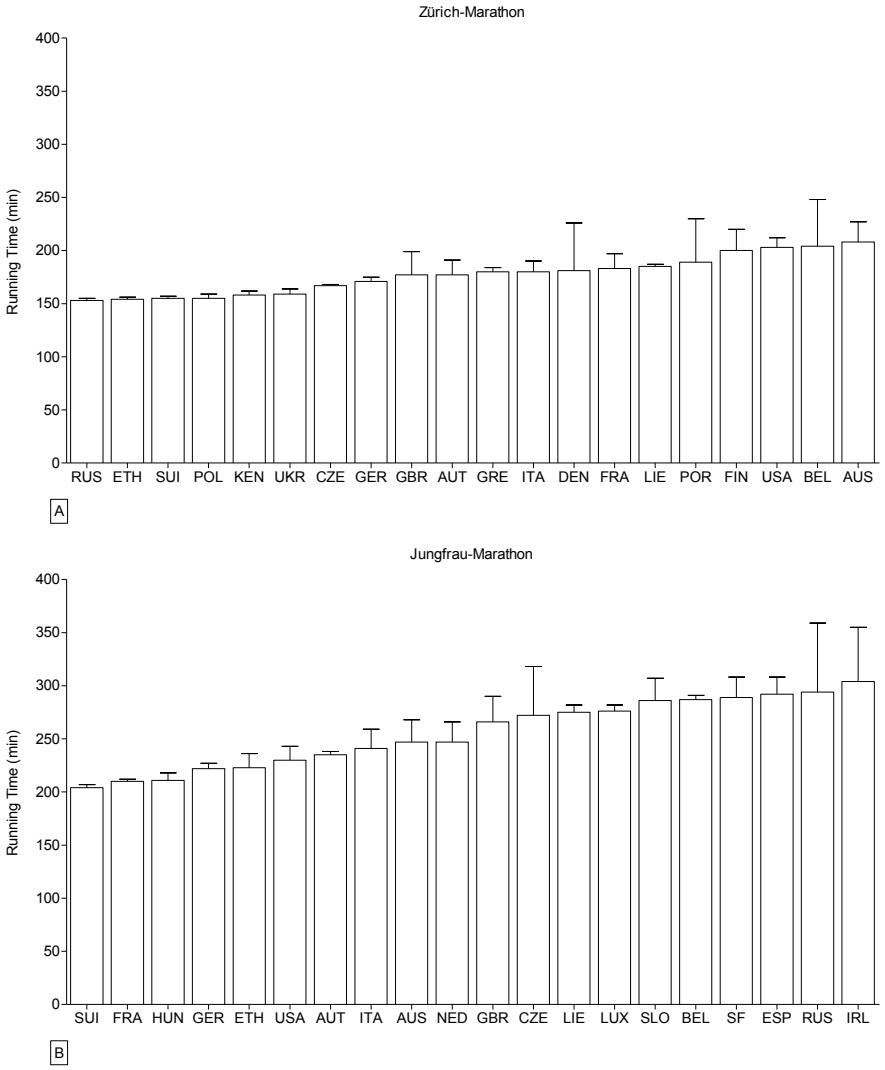

Figure 4. *Running time of the top three female athletes per nation competing in `Zürich Marathon` (Panel A) and `Jungfrau Marathon` (Panel B). Nations are arranged by running time and the frame indicates only the 20 fastest nations. Panel A: RUS=Russia, ETH=Ethiopia, SUI=Switzerland, POL= Poland, KEN=Kenya, UKR= Ukraine, CZE=Czech Republic, GER=Germany, GBR=Great Britain, AUT=Austria, GRE=Greece, ITA=Italy, DEN=Denmark, FRA=France, LIE=Liechtenstein, POR=Portugal, FIN=Finland, USA=United States of America, BEL=Belgium, AUS=Australia, Panel B: SUI=Switzerland, FRA=France, HUN=Hungary, GER=Germany, ETH=Ethiopia, USA=United States of America, AUT=Austria, ITA=Italy, AUS=Australia, NED= Netherlands, GBR=Great Britain, CZE=Czech Republic, LIE=Liechtenstein, LUX=Luxembourg, SLO=Slovenia, BEL=Belgium, SF=Finland, ESP=Spain, RUS=Russia, IRL=Ireland.*

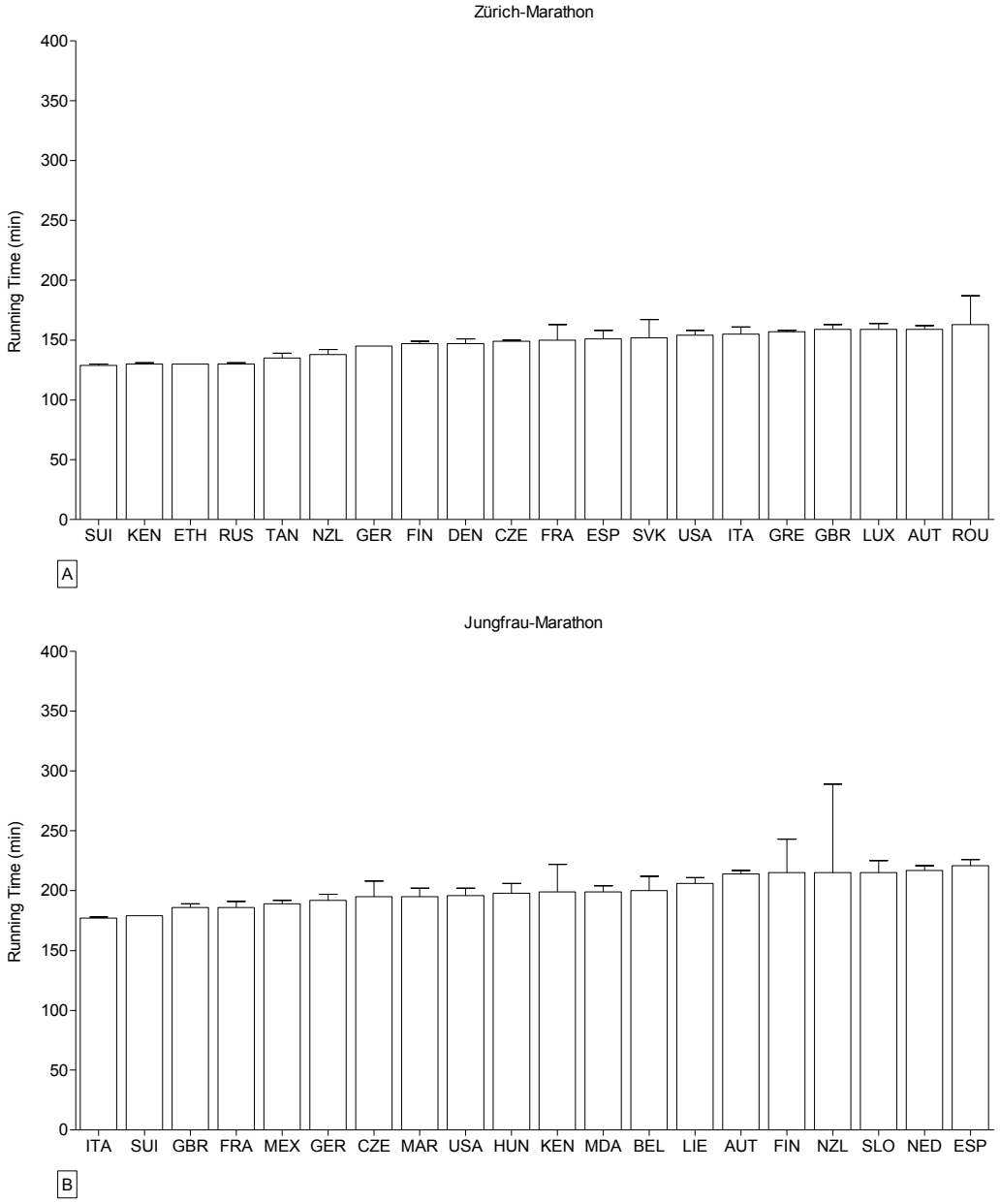

Figure 5. *Running time of the top three male athletes per nation competing in `Zürich Marathon` (Panel A) and `Jungfrau Marathon` (Panel B). Nations are arranged by running time and the frame indicates only the 20 fastest nations. Panel A: SUI=Switzerland, KEN=Kenya, ETH=Ethiopia, RUS=Russia, TAN=Tanzania, NZL=New Zealand, GER=Germany, FIN=Finland, DEN=Denmark, CZE=Czech Republic, FRA=France, ESP=Spain, SVK=Slovakia, USA=United States of America, ITA=Italy, GRE=Greece, GBR=Great Britain, LUX=Luxembourg, AUT=Austria, ROU=Romania. Panel B: ITA=Italy, SUI=Switzerland, GBR=Great Britain, FRA=France, MEX=Mexico, GER=Germany, CZE=Czech Republic, MAR=Morocco, USA=United States of America, HUN=Hungary, KEN=Kenya, MDA=Moldova, BEL=Belgium, LIE=Liechtenstein, AUT=Austria, FIN=Finland, NZL=New Zealand, SLO=Slovenia, NED=Netherlands, ESP=Spain.*

There were no statistically significant differences in running times between female and male Kenyans and their leading opponents of other nations. The sex difference in running time was 21.5% for Kenyans, 20.1% for Swiss and 17.7% for Russians, respectively.

Performance of Kenyans in the mountain marathon

The overall top three male Kenyan athletes achieved with a mean running time of 199±23min the 11th fastest time behind athletes originating from Italy (177±1min), Switzerland (179±0min), France (186±5min), Great Britain (189±3min), Mexico (189±3min), Germany (192±5min), Czech Republic (195±13min), Morocco (195±7min), USA (196±6min) and Hungary (198±8min) (Figure 5B). There were no statistically significant differences in running times between male Kenyans and the leading male athletes from other nations. Female Kenyan athletes did not participate in the mountain marathon. The fastest running times for African women were achieved by Ethiopian runners. They reached the 5th fastest running time with 223±13min (Figure 4B). The fastest female running times were achieved by athletes originating from Switzerland with 204±3min (Figure 4B). The sex difference in running time was 17.9% for Ethiopians and 13.9% for Swiss athletes, respectively.

DISCUSSION

The aim of the present study was to compare the running performance between Kenyan athletes and athletes of other nations in a mountain versus a flat city marathon, both held in Switzerland during the 2003-2011 period. The main findings were: Firstly, in the mountain marathon top three male Kenyans achieved only the 11th fastest running time, secondly, female Kenyan athletes did not even participate in the mountain marathon and, thirdly, in the city marathon top three male Kenyan athletes achieved the second fastest running time behind Swiss athletes while Kenyan female runners had the fifth fastest running time.

Participation

In both marathons 99% of the participants originated from Europe. This overrepresentation can be explained through the location in Europe and the different motivations of athletes to run a marathon (Eichenberger et al., 2012). It is easier for Europeans to attend that contests and European athletes also run for competition, personal goal achievement, recognition, self-esteem enlargement or to stay healthy in spite of Africans especially Kenyans (Masters & Ogles, 1995). Women represented in both marathons a minority. In the flat city marathon female participation was 17.9% and in the mountain marathon it was 14.1%. This percentage accords with the reported data in literature that female athletes are still numeric inferior in marathons but there is a tendency of increasing female participants in these events because of their rising interest and open mindedness to endurance events (Hunter & Stevens 2013, Lepers & Cattagni, 2012). The rising number of athletes in the mountain marathon and the increasing number of athletes in the flat city marathon over eight years can be explained that mountain marathons or ultra marathons became more popular and athletes search for new competitions (Eichenberger et al., 2012).

Performance of Kenyan runners in the mountain marathon

The most important finding of this study was that the overall top three male Kenyans only achieved the 11th fastest running time in the mountain marathon despite of their superior running economy and their adaptation to altitude. The fastest male running time was achieved by male athletes originating from Italy. Female Kenyan athletes did not even participate in the mountain marathon. The main reason for this outcome seems to have a financial origin. Kenyans primary run for a financial profit (Onywera et al., 2006; Wilber & Pitsiladis, 2012; Eichenberger et al., 2012). The relatively low financial benefit of 10.000 Swiss

francs for a victory (www.jungfrauzeitung.ch), the lower commercial potential and the smaller interest of media in mountain marathons in comparison to road marathons (Gratton et al., 2006) might be not enough motivation for the best male Kenyans to prepare or in the case of female Kenyans even run a mountain marathon. In an analysis of Kenyan participation and performance trends in a Swiss mountain ulta-marathon Eichenberger et al. (2012) also gave the low financial benefit for a victory as a reason for the low participation and performance of Kenyans in these contests. Kenyan athletes seem to prefer running the financially better profitable city marathons especially from the `World Marathon Majors League`. In the year 2012-2013 the first eleven places for both sexes were occupied by East African athletes, respectively. For women, the winner Mary Keitany and additionally six other women originated from Kenya (www.worldmarathonmajors.com). For men, the winner Wilson Kipsang was equally placed with the Ugandan Tsegaye Kebede and eight other men originated from Kenya (www.worldmarathonmajors.com).

Performance of Kenyan runners in the flat city marathon

Another important finding was that male Kenyan athletes did not dominate the flat city marathon. They only achieved the second fastest mean running time behind the Swiss athletes. This finding was not in accordance with present data in literature reporting a Kenyan dominance in middle and long distance runs (Wilber & Pitsiladis, 2012). Like in the case of the mountain marathon the primary financial interest of Kenyans in marathons (Onywera et al., 2006; Wilber & Pitsiladis, 2012) seemed to be the main reason for this outcome. If we compared the overall top running times of the `Zürich Marathon` and the `New York City Marathon`, one of the five major city marathons of the world, in a 2003-2011 period Kenyan athletes achieved in contrast the fastest mean running times behind athletes from Ethiopia (http://web2.nyrrc.org). The reason for this finding could be the lower price money of 10,000 Swiss francs in `Zürich Marathon` (www.zurichmarathon.ch) in comparison to the `New York City Marathon` with 130,000 US dollars price money (www.ingnycmarathon.org). The primary financial interest of Kenyans to compete in marathons make them choose the better paid marathons like the `New York City Marathon`. Other possible explanations could be the increasing migration of male Kenyan athletes to financial better situated countries especially in North America, Europe and the Middle East and their performance for these nations (Simiyu et al., 2012a, 2012b). Another finding was that the top three female Kenyan athletes only performed the fourth fastest running time behind athletes originating from Russia, Ethiopia, Switzerland and Poland. A possible explanation for this finding, beside the financial aspect which also applies to Kenyan women, could be that running in Kenya is still a domain of men (Onywera, 2009; Shronz, 2002). A great part of Kenyan women are still forced to stay at home to make housework and breed their children (Onywera, 2009; Shronz, 2002). There is only a little number of competitive female Kenyan athletes, which also explains the greater Kenyan sex difference in running time of 21.5% in the flat marathon.

CONCLUSIONS

Kenyan race performances in both the flat city marathon and the mountain marathon were slower as expected. Despite of their excellent running economy and their adaptation to altitude European athletes achieved faster running times in both marathons. The difference in running performance between Europeans and Kenyans had been greater in the mountain marathon as in the flat marathon. The reasons for these outcomes are still unclear. Further researches are needed to investigate the reasons for the relative low participation and performance of Kenyan athletes in both the mountain and the flat city marathon in Switzerland.

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